

FIG. 1 **FIG. 2**

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T	Schemes	Applicability	Lookup Time	Memory	Update Time	Multicast
N	Patricia	1st, 2nd upto Last Hop Router	$O(\log(n))$	Low	Low	No
O	DP Trie	1st, 2nd upto Last Hop Router	$O(\log(n))$	Low	Low	No
N	LPCTrie	1st, 2nd upto Last Hop Router	$O(\log^*(n))$	High	Low	Yes
C	Lulea	1st, 2nd upto Last Hop Router	$<<O(\log(n))$	Low	High	No
O	CAM	1st, 2nd upto Last Hop Router	$O(1)$	—	High	Yes
P	DRAM	1st, 2nd upto Last Hop Router	$O(1)$	High	High	No
C	Tag Switching	2nd upto Last Hop Router	$O(1)$	High	High	Yes
O	MPLS	2nd upto Last Hop Router	$O(1)$	High	High	Yes
P	IP Switching	2nd upto Last Hop Router	$O(1)$	High	High	Yes
H	CLUE	2nd upto Last Hop Router	$O(1)$	High	Low	No

FIG. 3

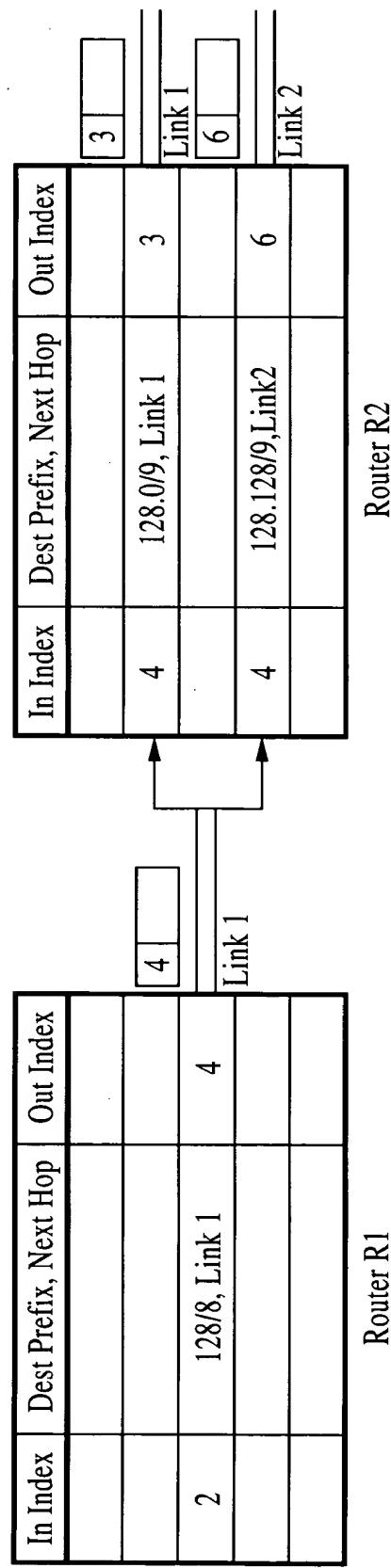
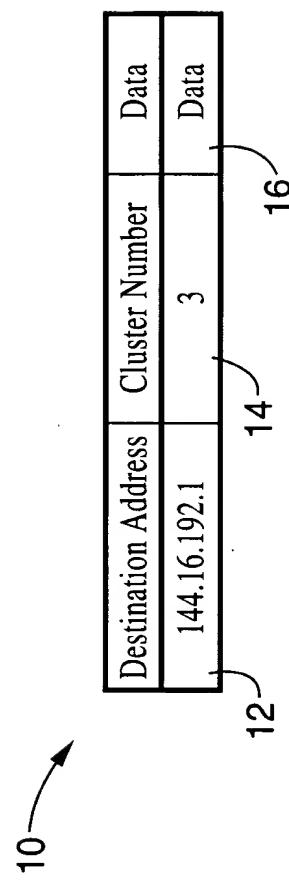


FIG. 4



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FIG

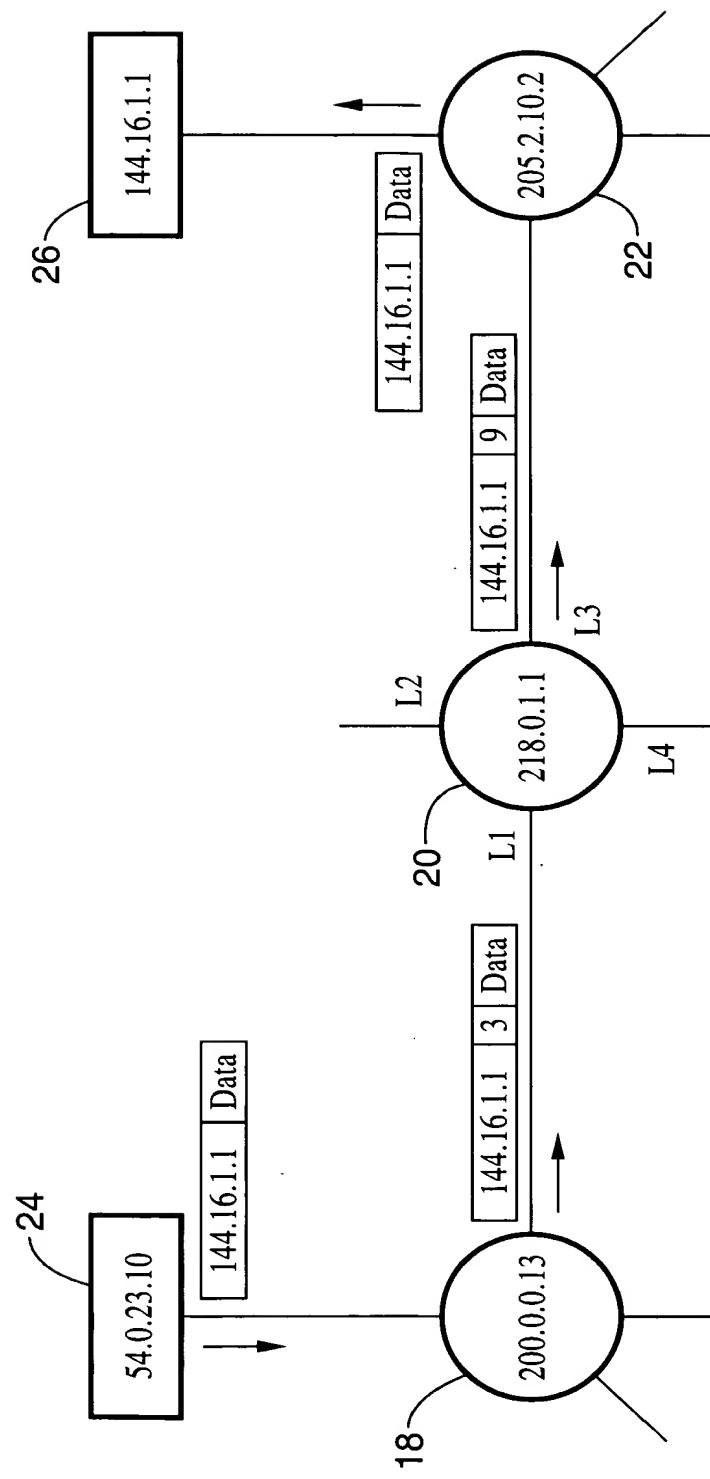


FIG. 6

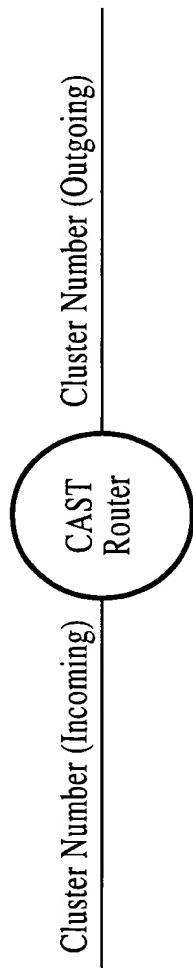


FIG. 7

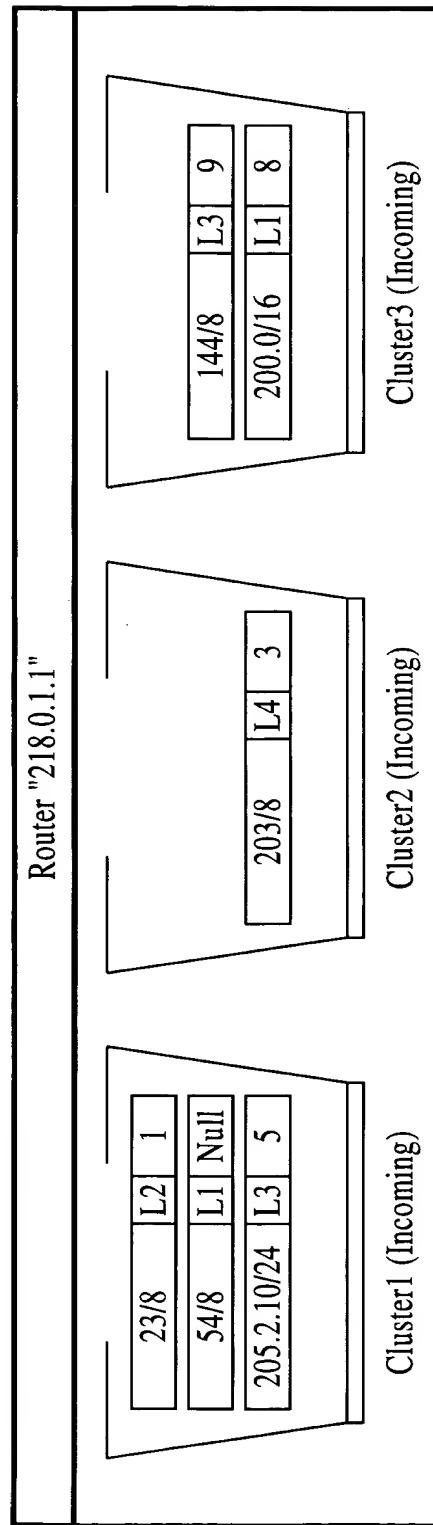


FIG. 8

Prefix Entry	Next Hop Link	Cluster Number (Outgoing)
144/8	L3	9

FIG. 9

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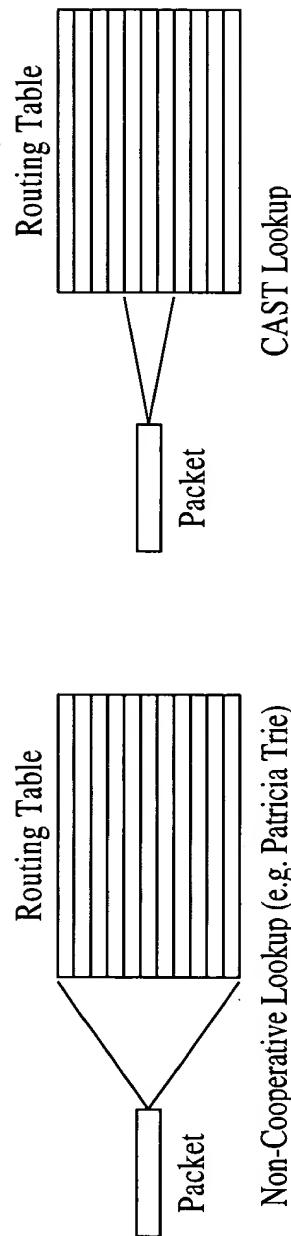
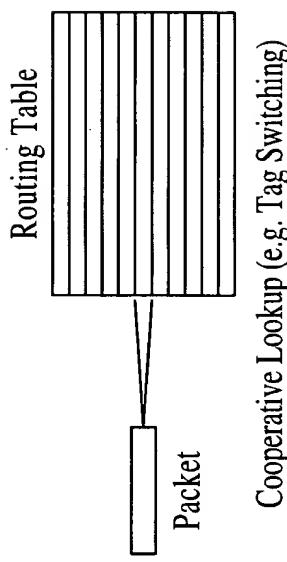


FIG. 10A

FIG. 10B



Cooperative Lookup (e.g. Tag Switching)

FIG. 10C

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Technique	Applicability
Patricia	2nd upto Last Hop Router
Symmetric	1st, 2nd upto Last Hop Router
Link	2nd upto Last Hop Router

FIG. 11

Prefix	Next Hop Link	Cluster Number (Outgoing)
0000*	L2	2
00010*	L3	3
00011*	L2	2
1000*	L1	4
100100*	L2	1

FIG. 12

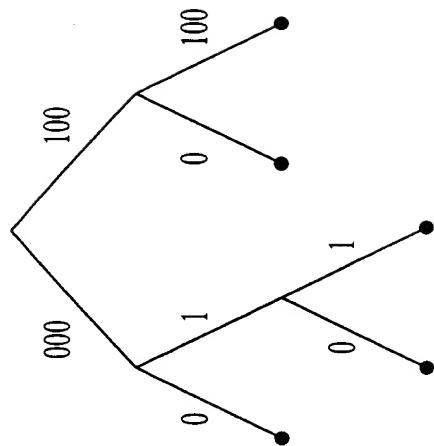
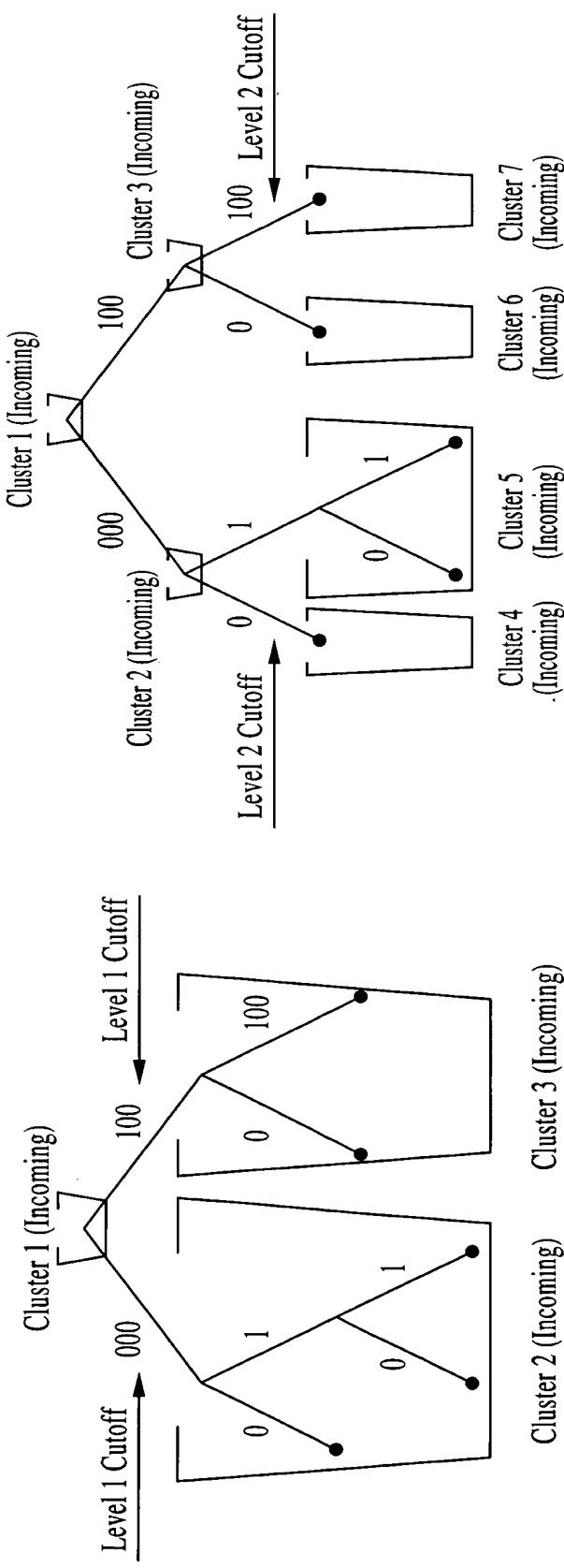


FIG. 13

**FIG. 14****FIG. 15**

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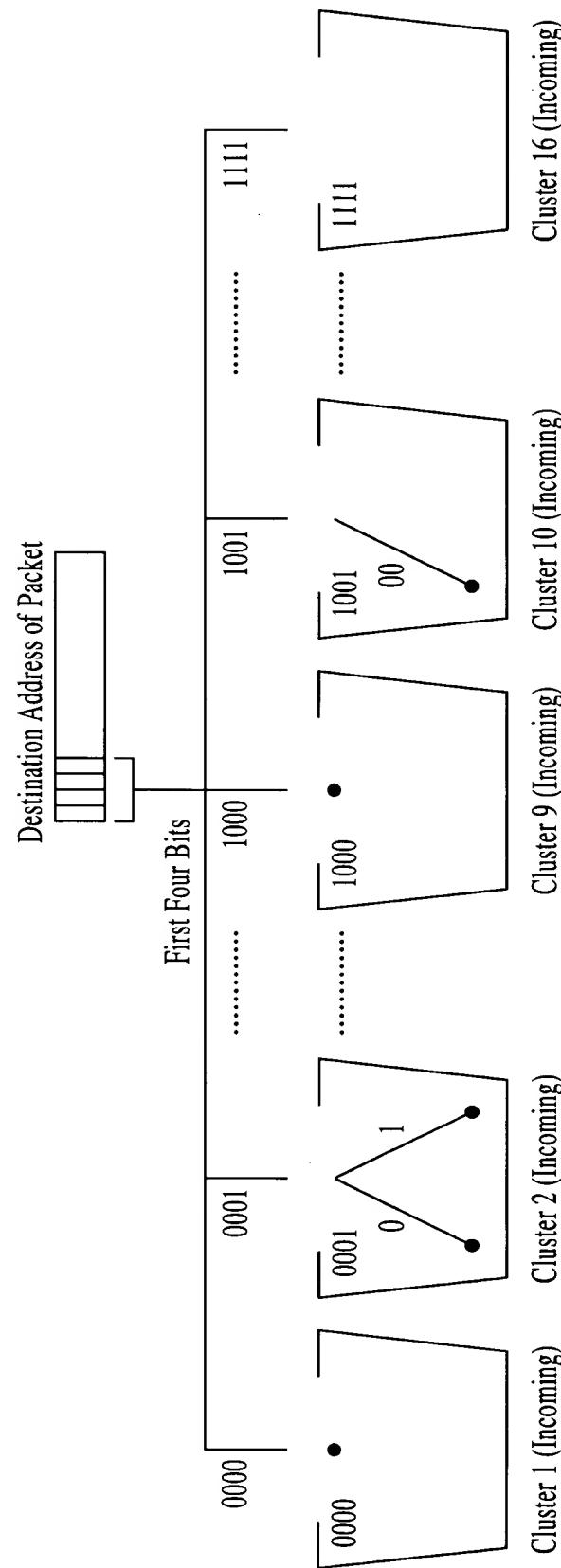


FIG. 16

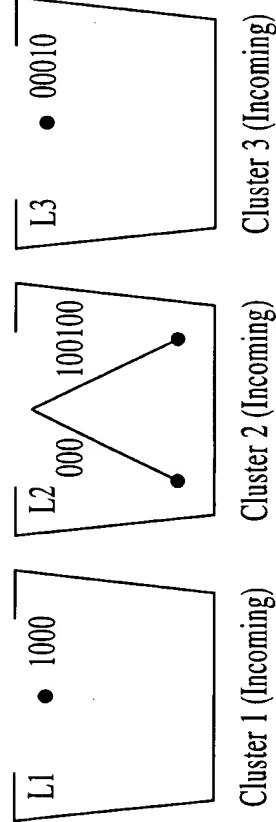


FIG. 17

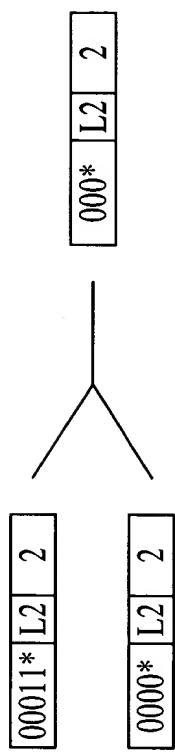


FIG. 18

DATA STRUCTURE

```
struct CAST_ROUTING_TABLE
{
    PREFIX_TABLE PT;
    CONFLICT_TABLE CT;
    CLUSTER_TABLE_INCOMING CTI;
    CLUSTER_TABLE_OUTGOING CT0;
    NEIGHBOR_TABLE NT;
}
```

FIG. 20A

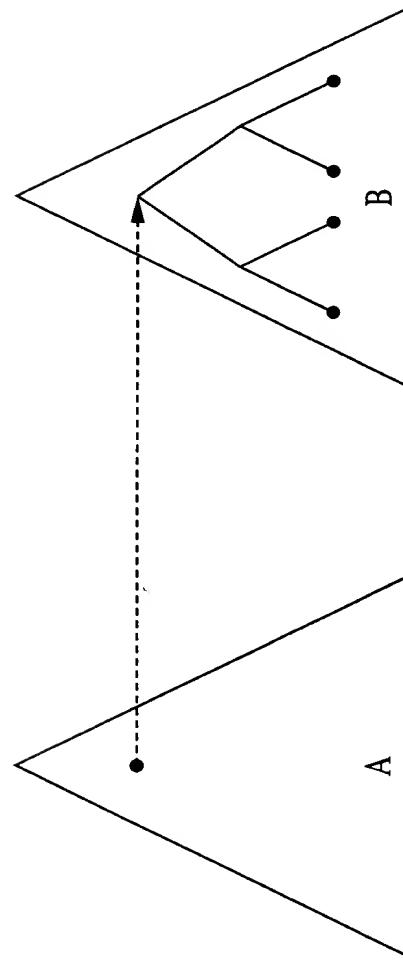


FIG. 19

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TABLES

PREFIX TABLE		
CHILD	PREFIX	SKIP
		(TO LEFT CHILD OR CLUSTER TABLE (OUTGOING) OR CONFLICT TABLE)
⋮	⋮	⋮
		⋮
1 bit	1 bit	5 bits

17 bits

CONFLICT TABLE		
POINTER (TO LEFT CHILD)	POINTER (TO CLUSTER TABLE (OUTGOING))	
	⋮	⋮
	⋮	⋮
	⋮	⋮
15 bits		17 bits

CLUSTER TABLE (INCOMING)	
PATRICIA START LENGTH	
⋮	⋮
⋮	⋮
⋮	⋮
5 bits	

CLUSTER TABLE (OUTGOING)	
CLUSTER NUMBER (OUTGOING)	POINTER (TO NEXT HOP TABLE)
	⋮
	⋮
	⋮
7 bits	

NEXTHOP TABLE	
NEXTHOP	
⋮	⋮
⋮	⋮
⋮	⋮
32 bits	

FIG. 20B

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Procedure: CAST_Forward_Packet(Packet packet)

Upon receiving an unicast packet this procedure is called in a CAST router

```

begin
  if((packet.cluster.no.incoming = 'Null') or packet.cluster.no.incoming doesn't exist) then
    **Symmetric Clustering**
    cluster_no_symmetric ← Binary_to_decimal(packet.destination, symmetric_start_length)
    pointer_cluster_outgoing ← Search_prefix_table(cluster_no_symmetric, symmetric_start_length, packet.destination, PT, CT)
    cluster_no_outgoing ← CTO[pointer_cluster_outgoing].cluster_no_outgoing
    pointer_nexthop ← CTO[pointer_cluster_outgoing].cluster_no_outgoing
    nexthop ← NT[pointer_nexthop].pointer_nexthop
    Sendpacket (cluster_no_outgoing, nexthop)
  else
    **Patricia Clustering**
    patricia_start_length ← CTI[packet.cluster_no_incoming]
    pointer_cluster_outgoing ← Search_prefix_table(packet.cluster_no_incoming, patricia_start_length, packet.destination, PT, CT)
    cluster_no_outgoing ← CTO[pointer_cluster_outgoing].cluster_no_outgoing
    pointer_nexthop ← CTO[pointer_cluster_outgoing].pointer_nexthop
    nexthop ← NT[pointer_nexthop].pointer_nexthop
    Sendpacket (cluster_no_outgoing, nexthop)
  endif
end

```

FIG. 20C

DATA STRUCTURE

```

struct CAST_ROUTING_TABLE
{
  LINK-PREFIX_TABLE PT
  CONFLICT_TABLE CT
  CLUSTER_TABLE_INCOMING CTI
  CLUSTER_TABLE_OUTGOING CTO
}
  
```

FIG. 21A
TABLES

CLUSTER TABLE (INCOMING)	
NEXTHOP	POINTER (TO LINK-PREFIX TABLE)
⋮	⋮
⋮	⋮
32 bits	17 bits

CONFLICT TABLE	
POINTER (TO LEFT CHILD)	POINTER (TO CLUSTER TABLE (OUTGOING))
⋮	⋮
⋮	⋮
15 bits	17 bits

LINK-PREFIX TABLE			
CHILD	PREFIX	SKIP	POINTER (TO LEFT CHILD or CLUSTER TABLE (OUTGOING) or CONFLICT TABLE)
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
1 bit	1 bit	5 bits	17 bits

CLUSTER TABLE (OUTGOING)	
CLUSTER NUMBER (OUTGOING)	
⋮	⋮
⋮	⋮
⋮	⋮
8 bits	

FIG. 21B

APPROVED	O.G. FIG.
BY	CLASS SUBCLASS
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ALGORITHM

Procedure: CAST_Forward_Packet(Packet packet)
 Upon receiving an unicast packet this procedure is called in a CAST router

```

begin
  nexthop      ← CTT[packet.cluster_no_incoming].nexthop
  pointer_link-prefix_table ← CTT[pointer_cluster_outgoing].pointer_link-prefix_table
  pointer_cluster_outgoing ← Search_link-prefix_table(pointer_link-prefix_table, 0, packet.destination, PT, CT)
  cluster_no_outgoing      ← CTO[pointer_cluster_outgoing].cluster_no_outgoing
  Sendpacket (cluster_no_outgoing, nexthop)
end
  
```

Link Clustering

FIG. 21C

Router A		Router B	
Multicast Group	Next Hop Links	Multicast Group	Next Hop Links
224.1.2.1	L1,L3	224.1.2.3	L2,L3
224.1.2.3	L2	224.1.2.5	L4
224.1.2.4	L1,L3	224.1.2.9	L2,L3
224.1.2.8	L3		
224.1.2.9	L2		

FIG. 22

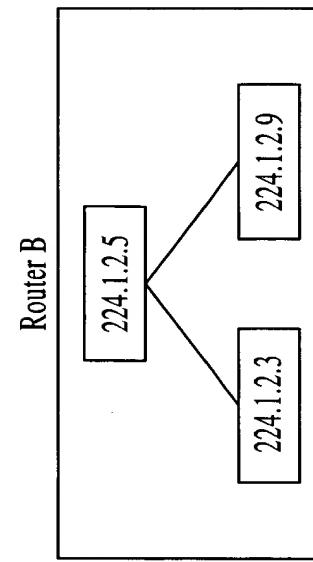
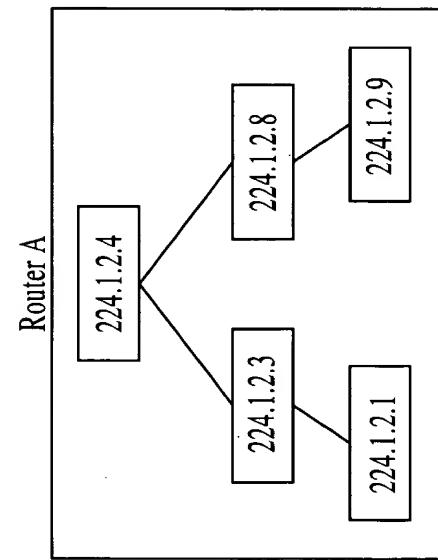


FIG. 23



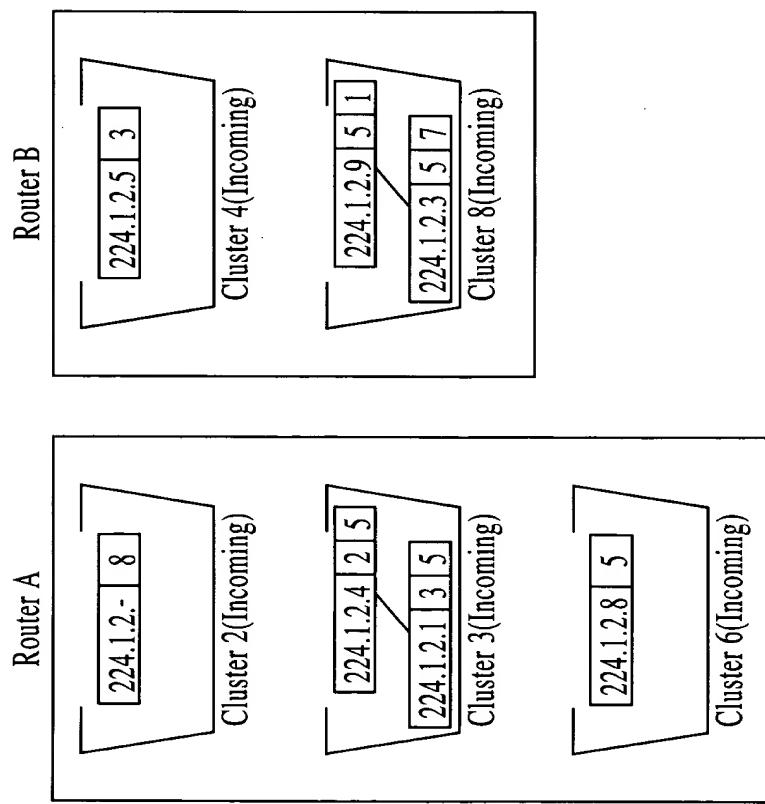


FIG. 24

Outgoing Links	Cluster No.
L1	1
L2	2
L3	3
L1,L2	4
L1,L3	5
L2,L3	6

FIG. 25

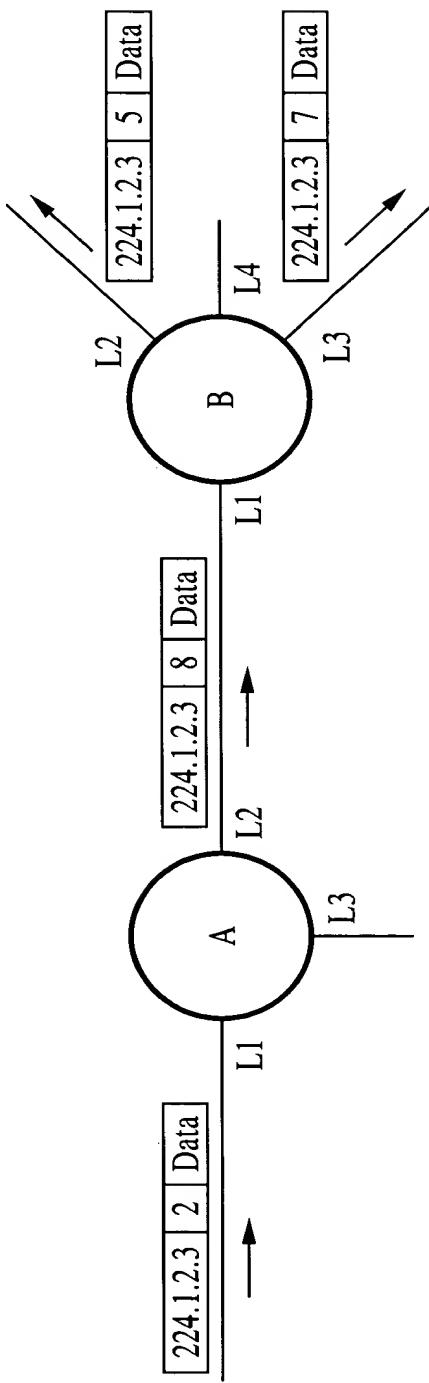


FIG. 26

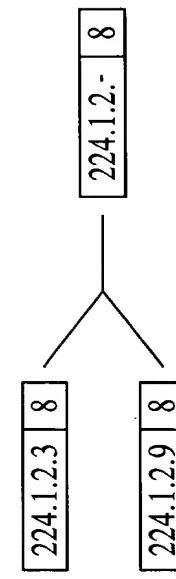


FIG. 27

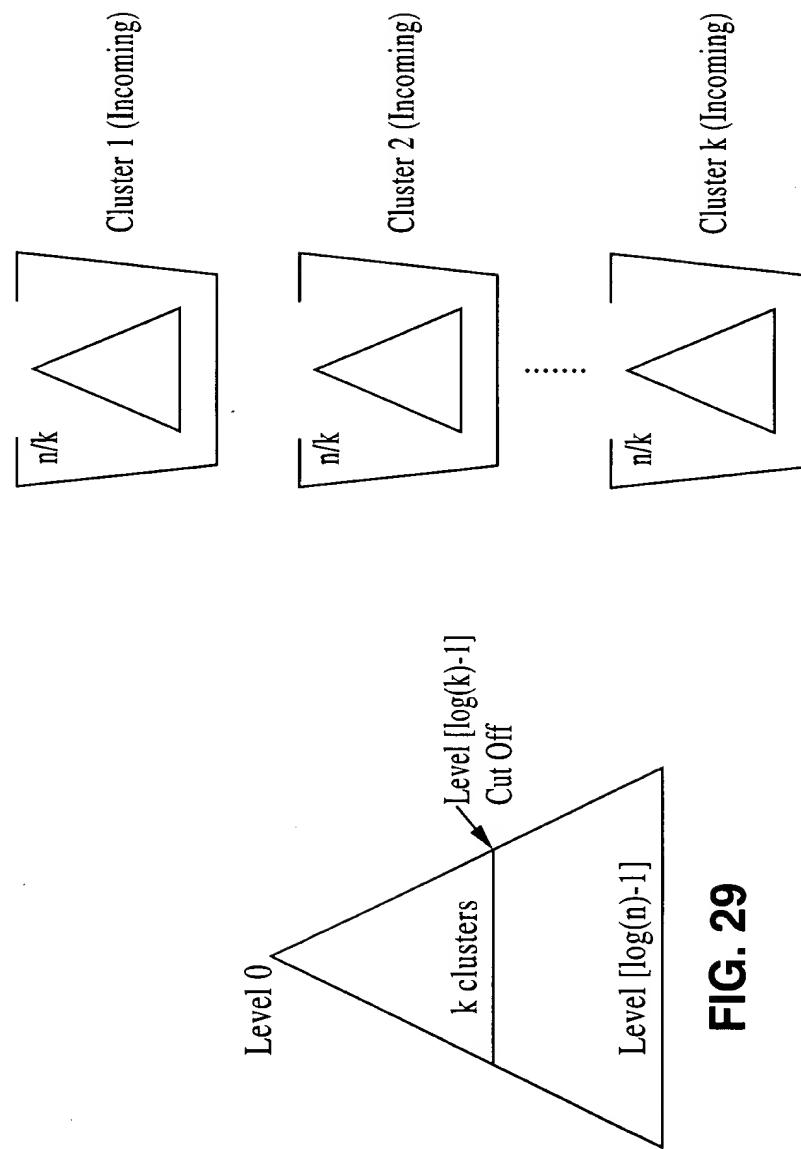


FIG. 29

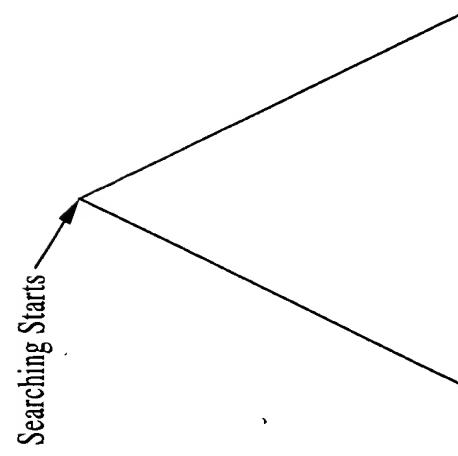


FIG. 28

FIG. 30

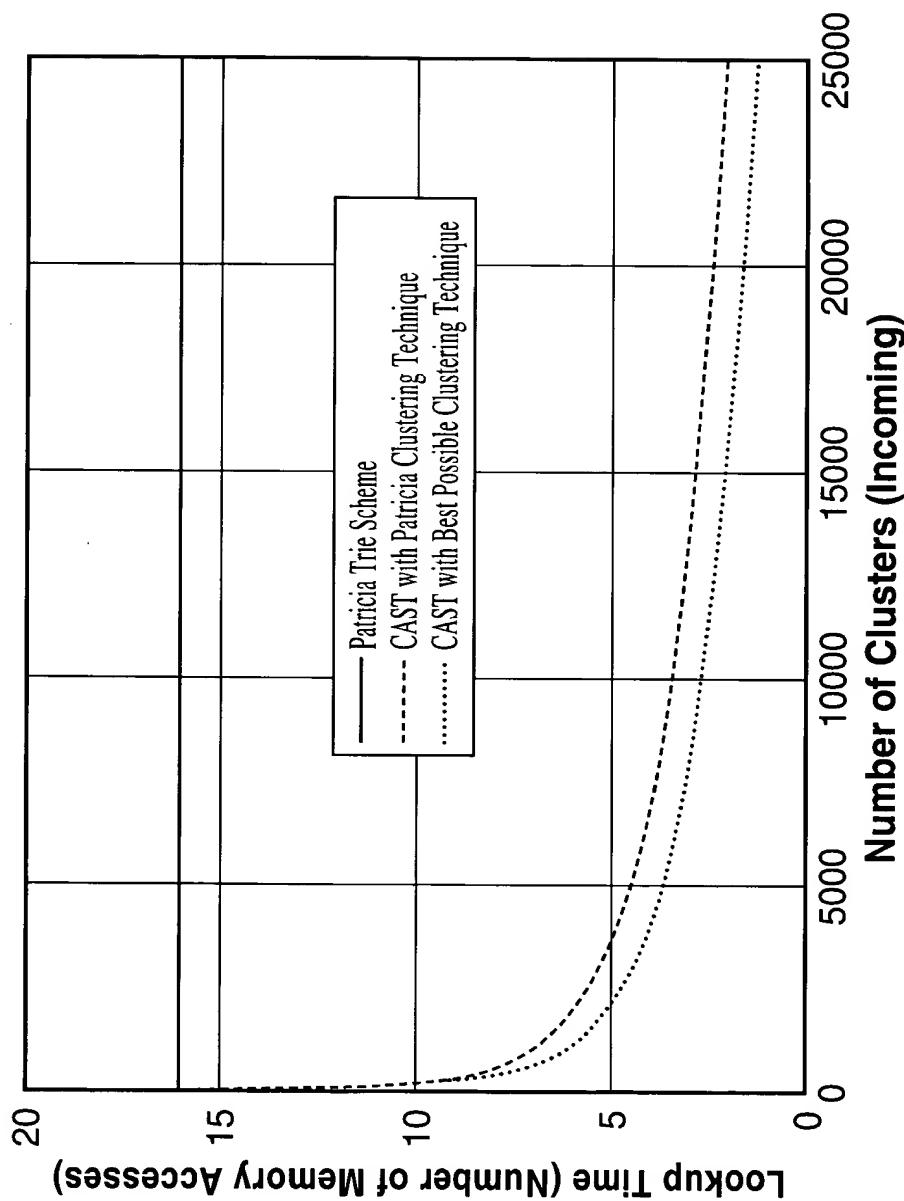


FIG. 31

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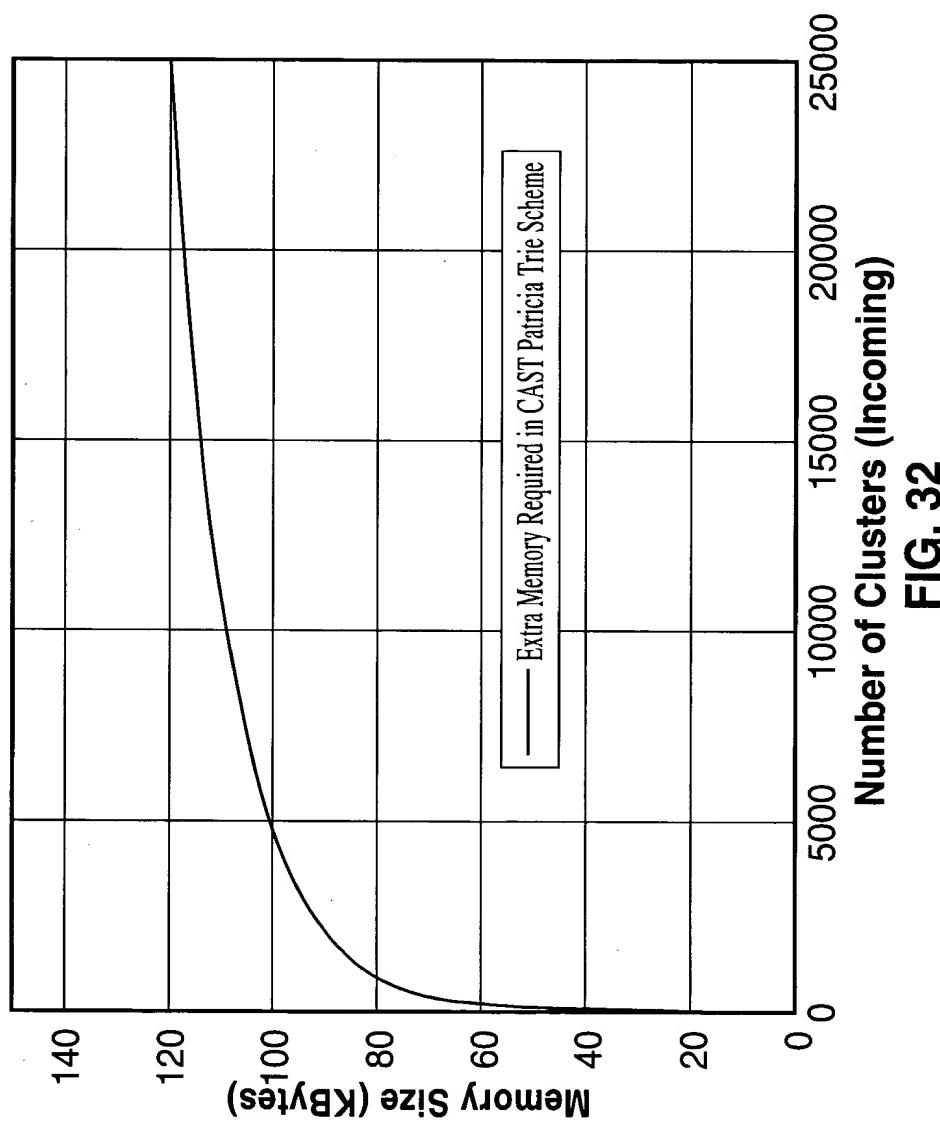


FIG. 32
Number of Clusters (Incoming)

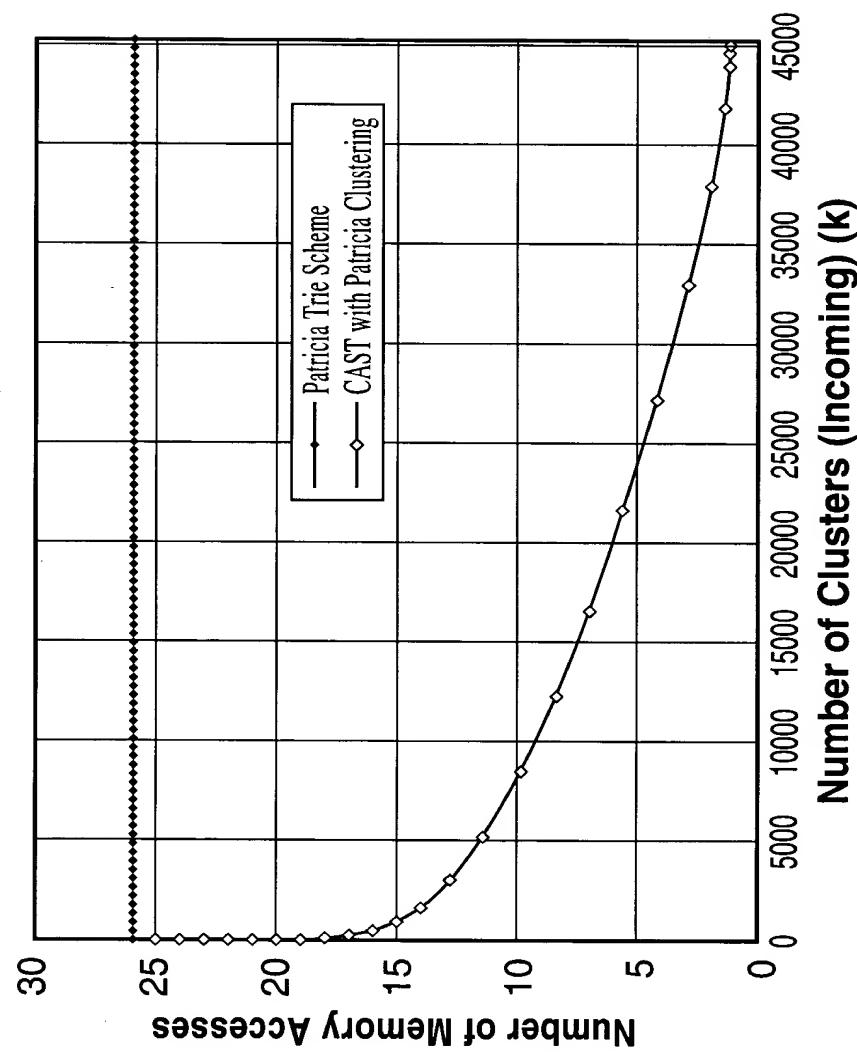


FIG. 33

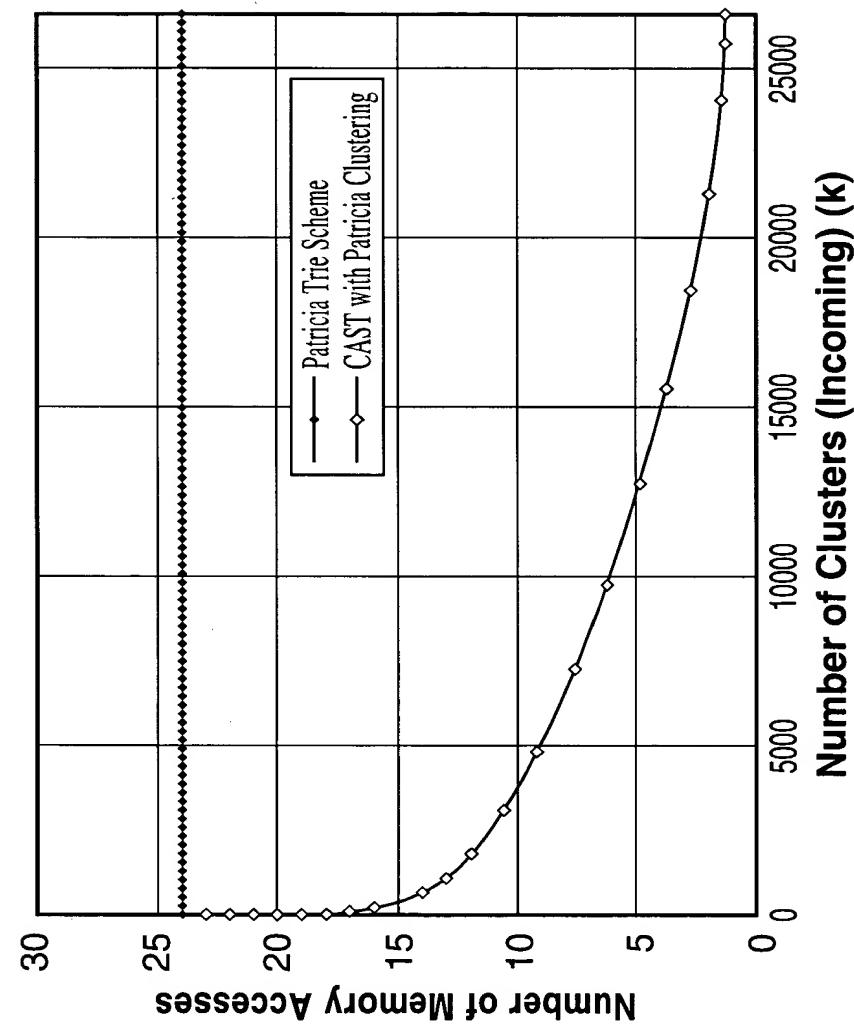


FIG. 34

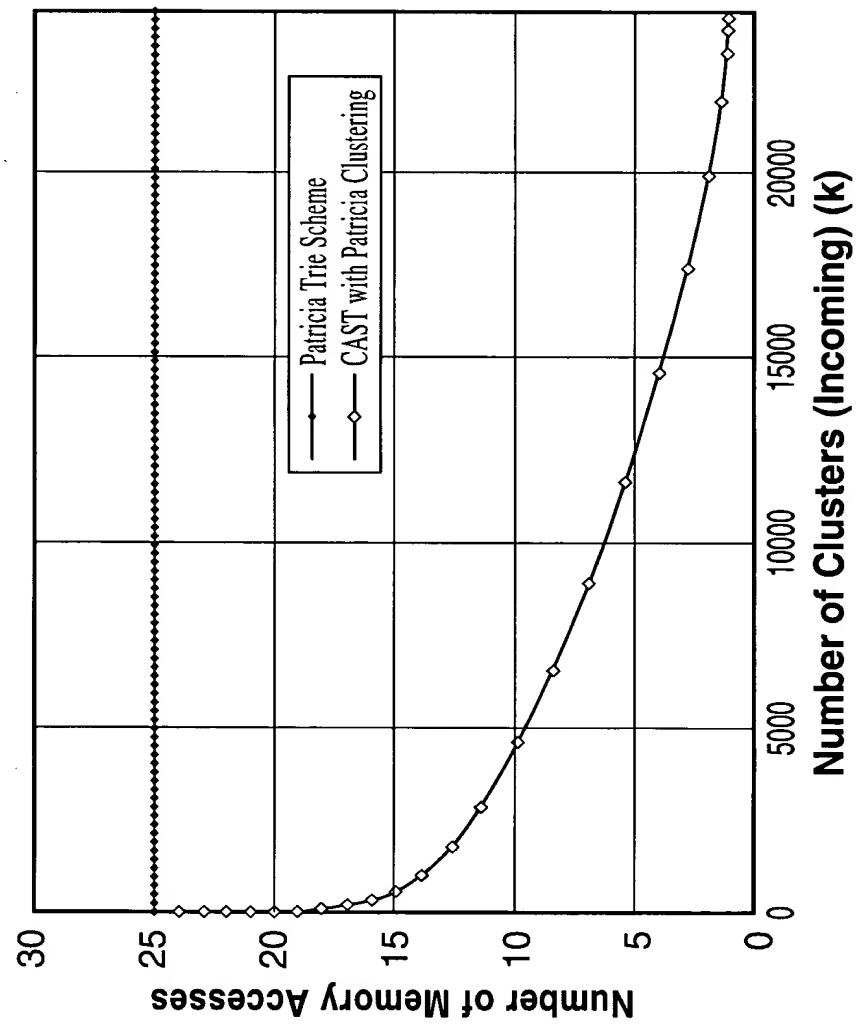


FIG. 35

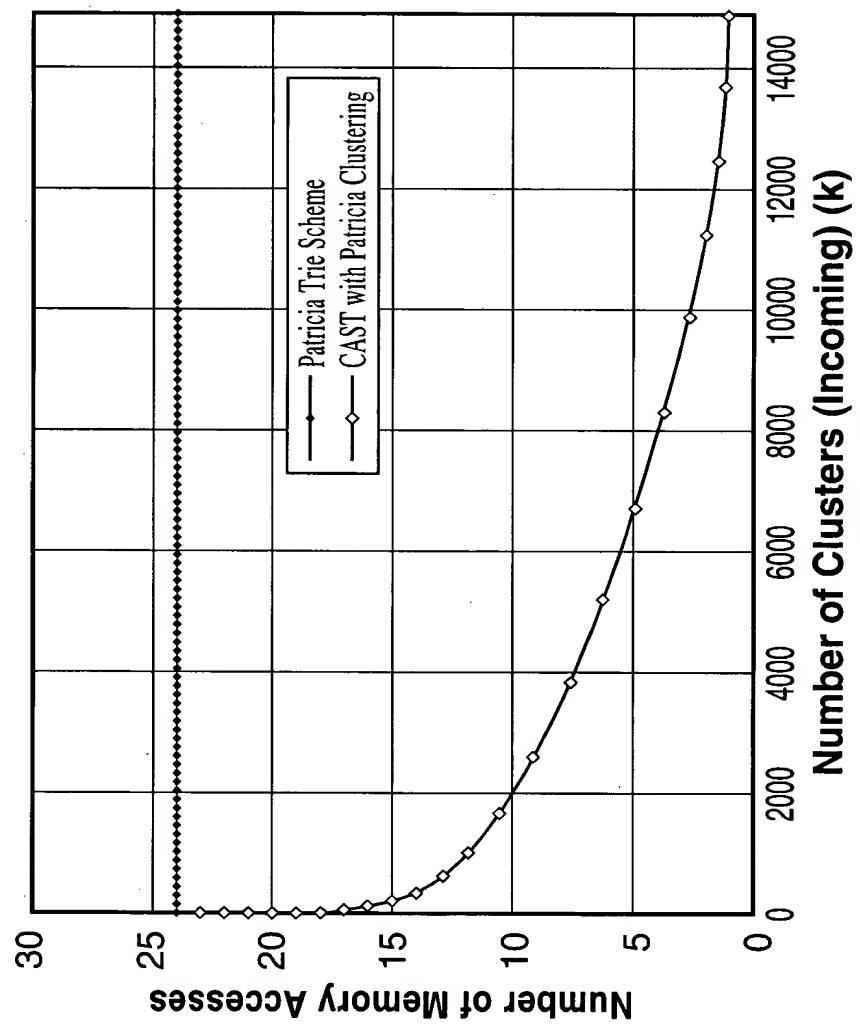


FIG. 36

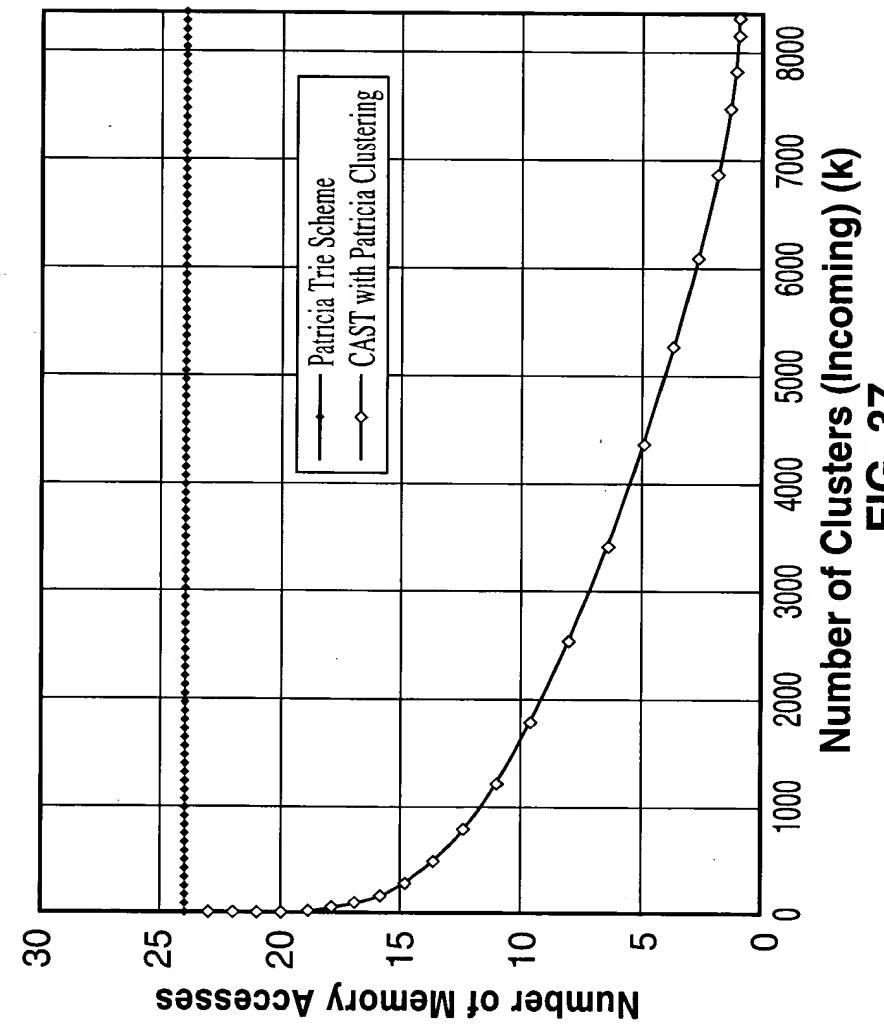


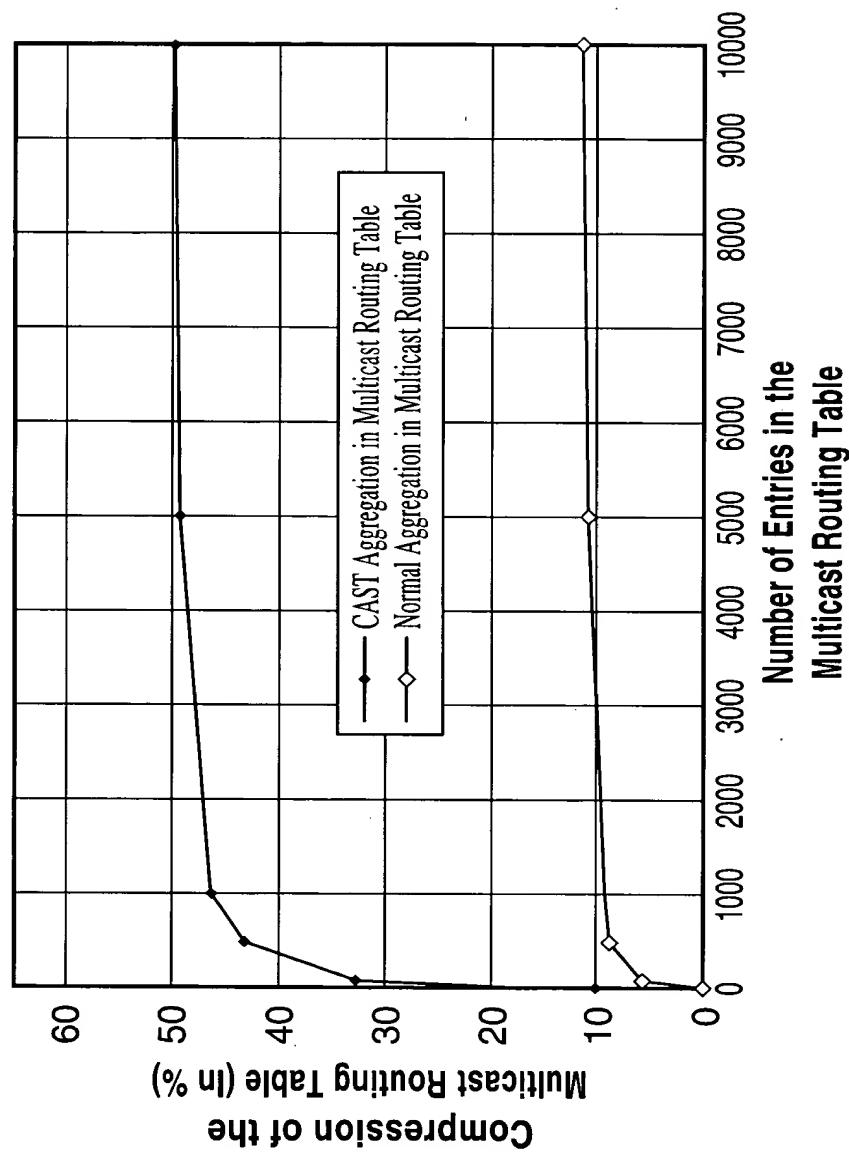
FIG. 37

Scheme	Actual Implementation Results				
	Lookup Power (MPPS)				
	MAE-EAST	MAE-WEST	PAC-BELL	AADS	PAIX
Patricia Trie	0.75	0.90	1.95	1.13	1.02
LPC	2.12	2.41	2.90	3.53	4.17
CAST (Patricia)	4.89	5.03	6.32	6.53	7.81
CAST (Symmetric)	0.92	1.07	2.19	1.26	1.25
CAST (Link)	0.96	1.11	2.20	1.27	1.27

FIG. 38

Scheme	Multicast Results (40,000 Entries)				
	Maximum (Memory Accesses)	Average (Memory Accesses)	Lookup Power (MPPS)	Memory (KBytes)	Update Time (Memory Accesses)
AVL Tree	16	15.21	1.31	1026	15.21
Tag Switching	1	1.00	20.00	1040	15.24
IP Switching	16	2.42	8.26	1862	30.43
CAST (Link clustering, 2048 Clusters(l))	7	4.17	23.98	889	15.18

FIG. 39



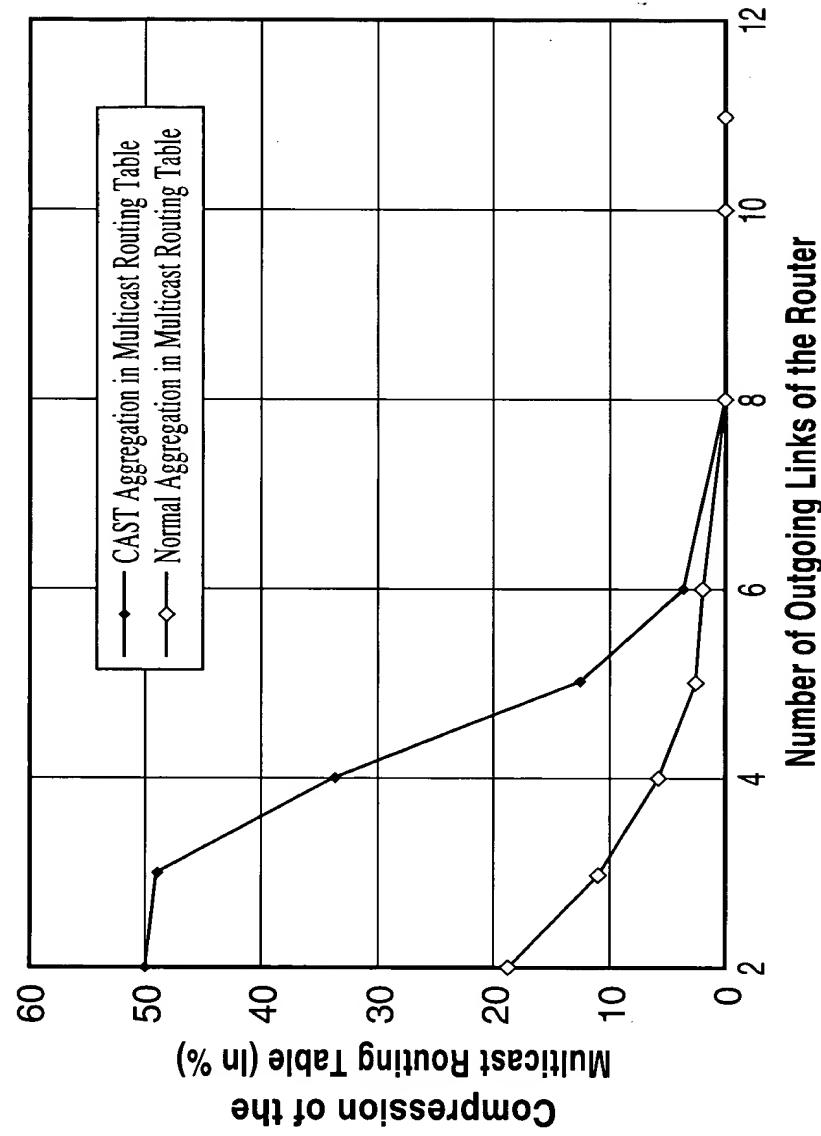


FIG. 41